United States Patent

[11] 3,616,901

[72] Inventor Charles Richard Groves
Worthington, Ohio
[21] Appl. No. 21,929
[22] Filed Mar. 23, 1970
[45] Patented Nov. 2, 1971
[73] Assignee Industrial Nucleonics Corporation

[54] ARTICLE-CLASSIFYING SYSTEM AND METHOD
21 Claims, 4 Drawing Figs.

[52] U.S. Cl. 209/74
[51] Int. Cl. B07c 5/02
[50] Field of Search 209/73, 74, 75

Primary Examiner—Allen N. Knowles
Assistant Examiner—Gene A. Church

Attorneys—Anderson, Luedeka, Fitch, Even and Tabin, William T. Fryer, III and C. Henry Peterson

ABSTRACT: Articles, such as cigarettes, are moved successively down a prescribed path past sensing and operating stations. Each article is categorized and the category, such as reject, is recorded in a respective memory cell of an addressable memory according to a memory-addressing signal formed as the difference between a counter signal and the address signal of the respective sensing station. When the article reaches the operating station, the recorded signal is read out from the respective memory cell by addressing it with a memory address signal formed as the difference between the counter signal and the address signal of the operating station. The readout signal is utilized to operate upon the article, as to reject a faulty cigarette from the path.

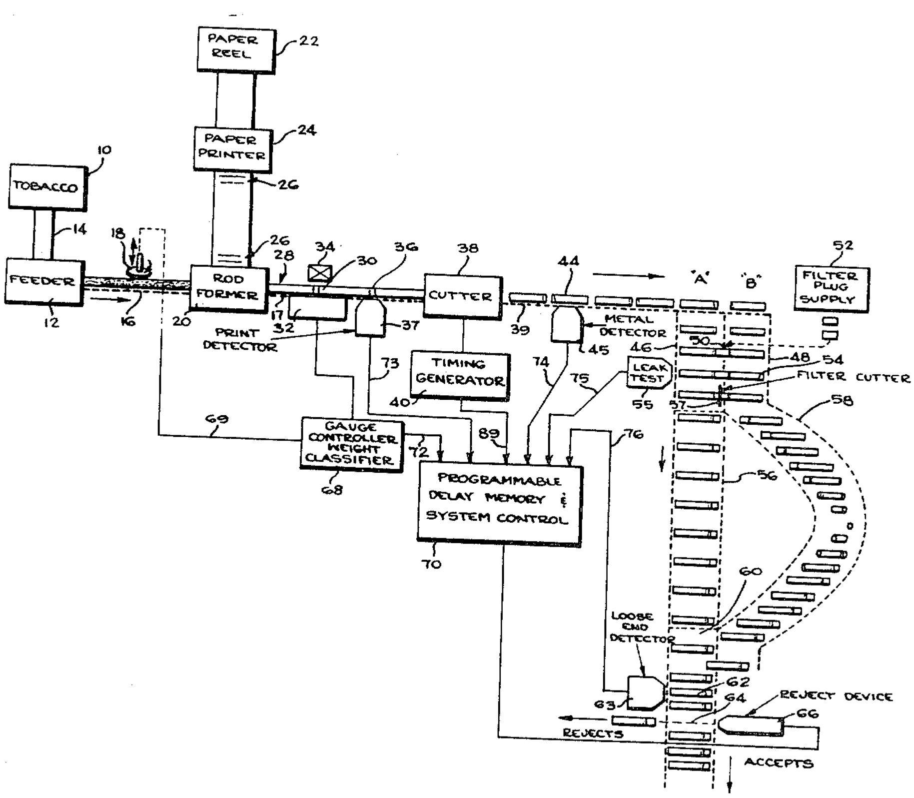
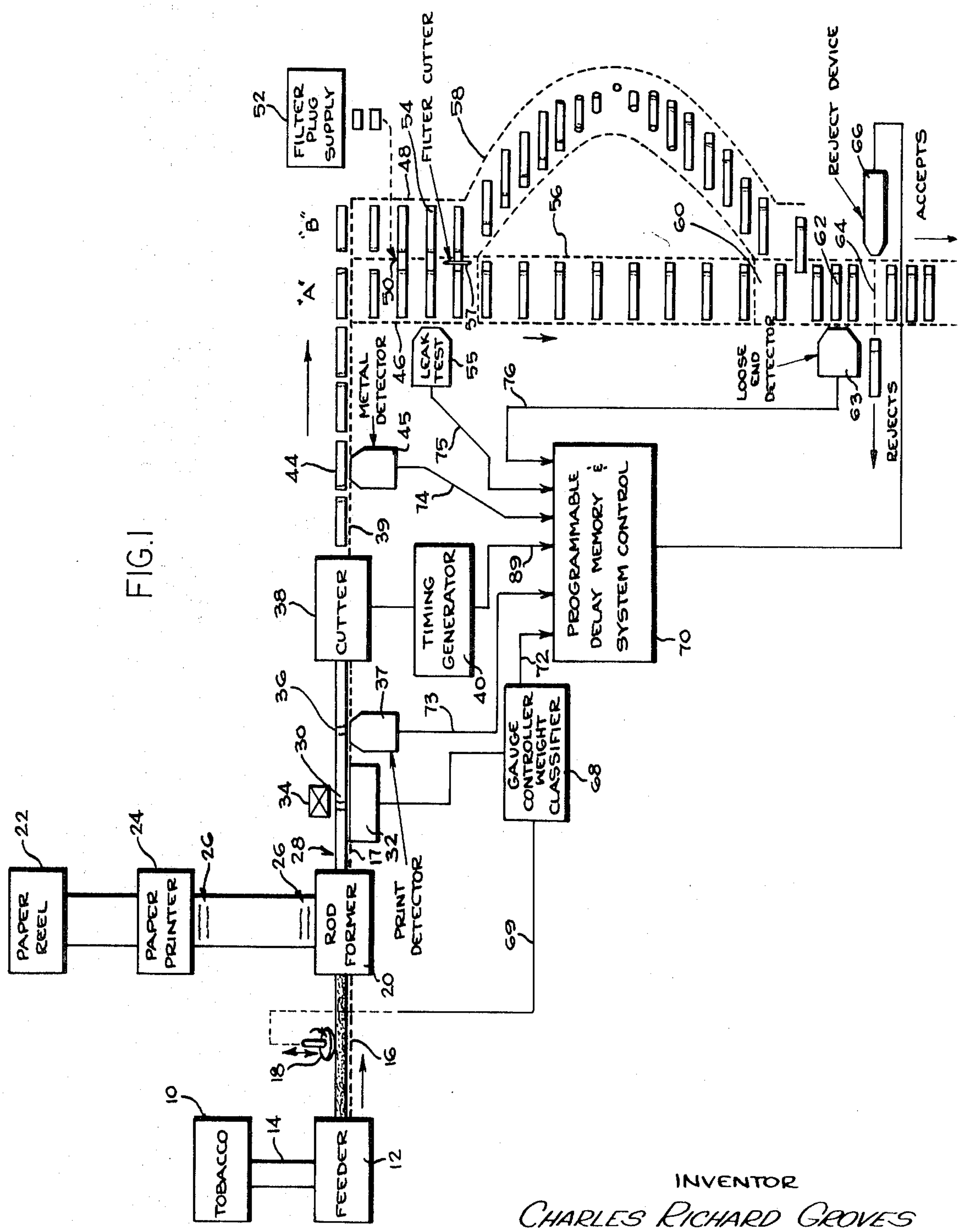


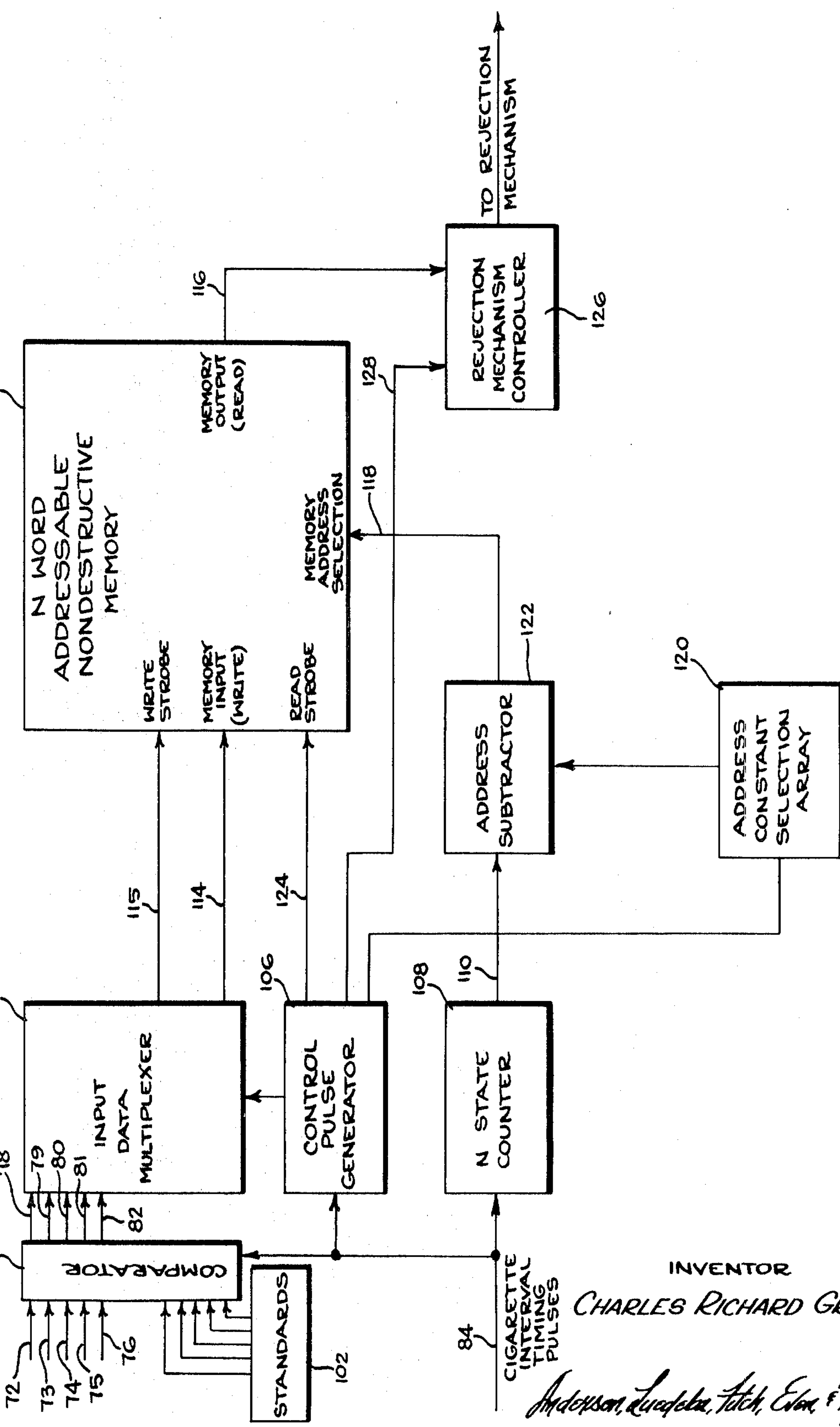
FIG. 1



INVENTOR
CHARLES RICHARD GROVES

Anderson, Luedeka, Fitch, Even & Tabin
ATTYS

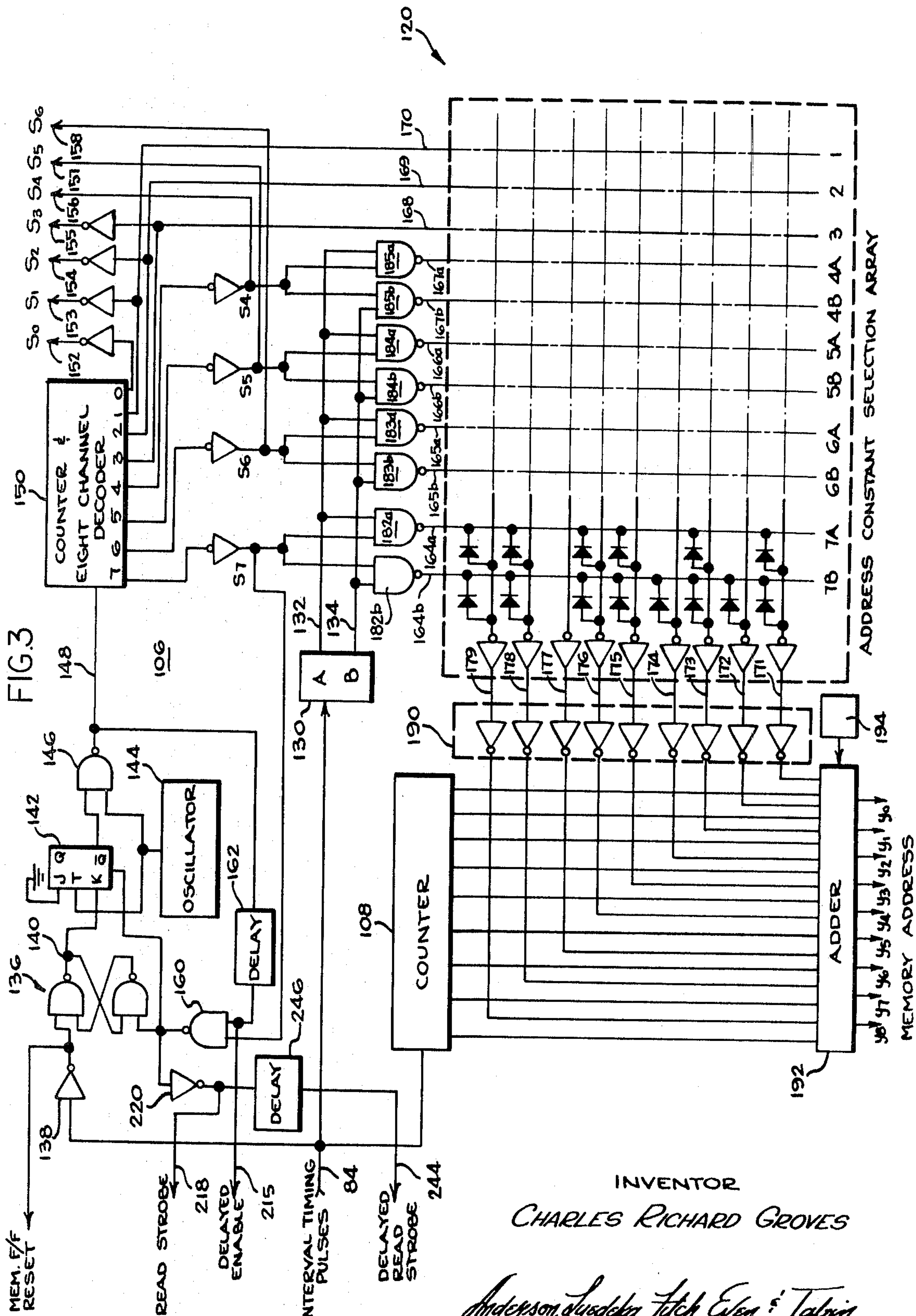
FIG.2



INVENTOR
CHARLES RICHARD GROVES

Anderson, Luedeka, Fitch, Even & Tabin
ATTYS.

FIG. 3



INVENTOR
CHARLES RICHARD GROVES

Anderson, Luedeka, Fitch, Even & Tabin
ATTYS.

PATENTED NOV 2 1971

3,616,901

SHEET 4 OF 4

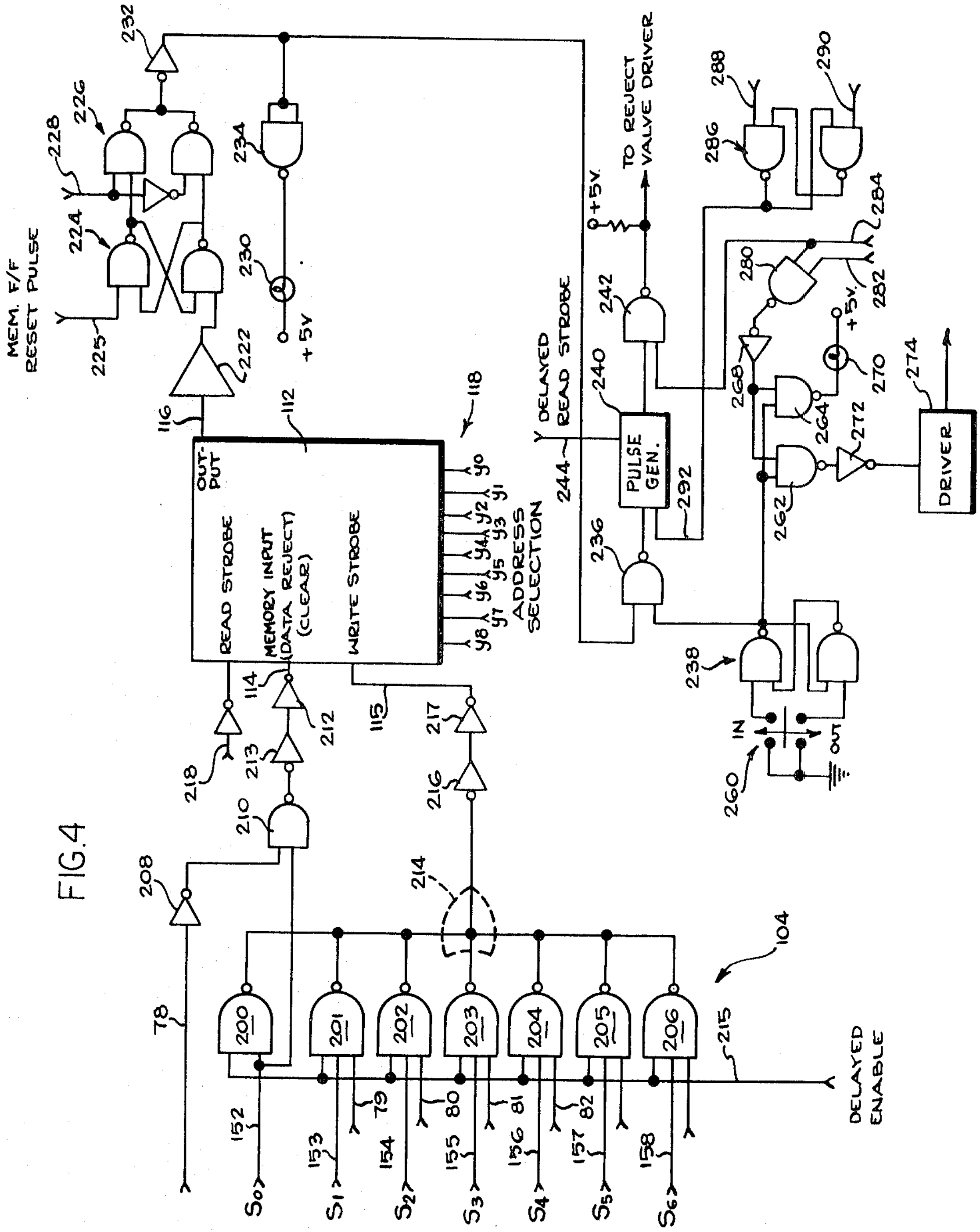


FIG.4

INVENTOR

CHARLES RICHARD GROVES

Anderson, Luedeka, Fitch, Even & Tabin
ATTYS.

ARTICLE-CLASSIFYING SYSTEM AND METHOD

The present invention relates to a method and system for classifying into categories, such as reject and accept categories, articles which are transported through an industrial process and automatically inspected or gauged in respect to one or more characteristics. More particularly, the present invention relates to such a classifier system and method for use in the manufacture of cigarettes for the detection of cigarettes varying from predetermined standards and the rejection or segregation of the cigarettes which do not conform to such standards.

In conventional cigarette-making machines it is common practice to monitor or detect various characteristics or properties of each cigarette during various stages of its manufacture, and to compare these detected characteristics with suitable standards to generate some form of indication of unacceptability. Those cigarettes in the reject category are rejected by a suitable reject or "kick-out" device, generally located near the detector. Typically, there are a number of characteristics which may be detected or sensed, including deviations in tobacco weight or density from a specified band of limits, excessive deviations in weight or density uniformity, deviations in the printed trademark or brand name position or print density from specified criteria, the presence of metal particles, excessive air leakage, the presence of loosely packed tobacco at the cigarette ends, missing filters, and deviations from a specified range of moisture content. The various particular transducing means for sensing these characteristics are, per se, well known in the art, and do not themselves form any part of the present invention.

Such cigarette-making machinery may typically employ various open and closed-loop servosystems for automatically monitoring various characteristics of the cigarettes during the manufacturing process, and may utilize derived feedback signals to control the manufacturing process to reduce deviations in these characteristics from preselected standards. However, in spite of the use of such automatic control systems, excessive deviations or variations from the acceptable standards may still result, at least in individual cigarettes, both with respect to those characteristics which are actually subject to such closed-loop servo control, such as tobacco weight and density, and with respect to those characteristics normally not subject to servocontrol, such as the presence of metal particles and loose ends.

It has been proposed to measure a number of characteristics and preserve the information for a single rejection device near the end of the cigarette line, prior to packaging. With the high speeds of the order of 3,000 to 4,000 per minute of modern cigarette production machinery, the inspection and rejection systems must be capable of accurately and separately collecting all of the desired information corresponding to each and every individual cigarette at rapid rates, storing this information, and delivering this information to the rejection device at precisely the time when the corresponding cigarette is in operable relation to the device.

While this may be at least partially achieved under certain conditions by employing delay devices such as various types of memory drums, wheels or discs and the like to establish the appropriate delay times, such drum or disc delay devices are relatively expensive to manufacture and maintain, and lack versatility. Moreover, such mechanically movable storage or delay media generally have inherent speed restrictions which reduce test accuracy with increasing production speeds or necessitate slower speeds to obtain the required test accuracies.

Accordingly, it is an object of the present invention to provide an improved system and method for classifying a plurality of articles, such as cigarettes, into either of two categories, such as for rejection or acceptance, according to sensed characteristics of each article transported through an industrial process at extremely high speeds.

It is another object of the present invention to provide such a classifier system and method therefor employing a tracking-type memory system which is suitable for use in high-speed cigarette-making machines, and which may readily utilize logic signal outputs from multiple classification sensors, each located at a different process point or station in the machine.

It is still another object of the present invention to provide an improved classifier system which has a high degree of flexibility and versatility to permit the relocation of the various classification sensors to any point or station location in the process without necessitating rewiring of the system to obtain the desired "delay" or storage time and thus can be modified easily to accommodate substantially any type of machine or process layout.

It is a further object of the present invention to provide such an improved classifier system embodied in apparatus which is relatively economical to manufacture and maintain and which employs standard commercially available components.

These and other objects of the invention are more particularly set forth in the following detailed description and in the accompanying drawings of which:

FIG. 1 is a general block and diagrammatic illustration showing the layout of a typical cigarette-making machine employing a classifier system in accordance with an embodiment of the present invention;

FIG. 2 is a functional block diagram showing the classifier system utilized in the cigarette-making machine of FIG. 1;

FIG. 3 is an electrical schematic and logic diagram showing a preferred logic arrangement for implementation of a portion of the system illustrated in FIG. 2; and

FIG. 4 is an electrical schematic and logic diagram showing the preferred logic arrangement for implementation of the remainder of the system illustrated in FIG. 2.

In general, the present system classifies a plurality of articles moving successively along one or more prescribed paths into either of first and second categories according to a sensed characteristic of each article. A suitable conveying means is provided for moving the articles successively along the paths past a reference point, one or more sensing stations, and an operating station. The reference point may be arbitrarily taken at any position along the paths, but is preferably selected at a position which results in the least complexity or cost of the system. Typically, each of the sensing stations may be located at a different preselected position along the paths relative to the reference point, and the operating station is located after the last sensing station.

The respective distances along the paths between each of the sensing stations and the reference point, as well as the distance between the operating station and the reference point, are herein conveniently measured in terms of an "article interval" which defines a unit of measurement indicative of an interval or space which may be generally occupied by a single article as it is moved along the prescribed paths by the conveying means. This is a fixed unit even though the actual absolute distance between the centers of articles as measured in linear units will typically differ at various locations along the path, depending on the relative speeds of various conveyors which may be employed, and the position or orientation of the articles relative to the direction of movement. Thus, in terms of "article intervals," and for any prescribed path, each of the sensing stations is located at a position which is a respective predetermined number of article intervals from the reference point, and the operating station is located a further predetermined number of article intervals from the reference point at a position following the last of the sensing stations along the path.

Sensing means are provided in association with each sensing station and are each responsive to a respective given characteristic of the article at each of the respective stations to provide information signals indicative of these respective given characteristics. Categorizing means are then provided responsive to these information signals to provide a category signal indicative of the category of the respective articles relative to each of the sensed characteristics. Associated with the operating station, an operating means, such as a reject or kickout mechanism, is provided for acting on the article thereat in a manner determined by the category information corresponding to the respective article.

To keep track of the category information relative to each sensed characteristic of each of the moving articles, a timing means is provided which is synchronized with the movement of the articles and which generates timing pulses indicative of each article interval movement along the prescribed paths. A counter responds to these timing pulses to count each article interval movement and provide a count signal indicative of the number registered in the counter. A memory is also provided which has a plurality of addressable discrete memory cells, input means through which signals may be written into the memory cells for storage, output means from which the stored signals may be read out, and address selection means for selecting the particular memory cells into which the signals at the input means are written and from which the stored signals are read at the output means.

To derive the appropriate memory addresses for writing into the memory the respective category information corresponding to each of the sensing means, and to read out the appropriate stored information corresponding to the article at the operating station, programmed addressing means are provided (1) to produce respective sensing station address signals corresponding to the predetermined number of article intervals that each respective sensing station is from the reference point, and (2) to produce an operating station address signal corresponding to the predetermined number of article intervals that the operating station is from the reference point. Then arithmetic combining means are provided which are responsive to sequential control signals (1) to combine the count signal of the counter and the respective sensing station address signals to produce successive memory address signals corresponding to the respective differences between the number registered in the counter and the predetermined number of article intervals that each of the sensing stations is from the reference point, and (2) to combine this same count signal and the operating station address signal to produce a reading memory address signal corresponding to the difference between the number registered in the counter and the predetermined number of article intervals between the operating station and the reference point.

The application of these writing and reading memory address signals to the address selection means is controlled by a cyclic switching means which is responsive to each timing pulse to provide the aforementioned sequential control signals to the arithmetic combining means during the time of each article interval movement. These control signals also synchronously apply those category signals which are indicative of a given one of the categories to the input means of the memory during the application of each respective writing memory address signal to the memory. These control signals also apply respective stored category information signals from the memory output means to the operating means during the application of the reading memory address signals to the memory.

Thus, the category information signals indicative of said given category are written into the memory when the respective articles are at their respective sensing stations, and the stored given category information associated with an article at the operating station is read from the memory and utilized to actuate the operating means when that respective article is at the operating station. Means are provided which are coupled to the memory and responsive to the cyclic switching means for clearing each respective memory cell no earlier than the reading of the stored signal therefrom, no later than the writing of the next category signal therein, and no later than during the application to the address selection means of the respective cell's writing memory address first occurring after this reading. This overall sequence of events takes place during the time period of an article interval movement, and continuously and cyclically repeats for each successive article interval movement as each of the articles is conveyed along the prescribed paths to the operating station.

The classifier system of the present invention is herein described as embodied in a cigarette-making machine for classifying the cigarettes into either a reject or an accept category, and those cigarettes which are in the reject category are removed from the process path at the operating station. More particularly, there is shown in FIG. 1 a cigarette-making machine utilizing a classifier system in accordance with an embodiment of the present invention, wherein five sensing stations are employed together with associated sensing means to monitor five different characteristics at different locations along a divided process path of the machine to determine the cigarettes having a characteristic which renders them defective, and ultimately utilizes this information to actuate a reject device at the operating station to segregate from the satisfactory cigarettes those which are defective.

In particular, the tobacco is fed from a suitable hopper or supply means **10** to a suitable feeding mechanism **12** via any suitable transfer means **14**. The tobacco slivers or shreds are fed by the feeder **12** onto a moving conveyor belt illustrated by broken line **16**. The tobacco stream is moved past a rotating trimmer or equalizing knife **18** which cuts off the portions of the tobacco shreds extending above the knife position to remove bunches and irregularities, and to control the density and packing of the tobacco as it enters the rod-forming apparatus **20** in a manner well known in the art. The rod-forming apparatus **20** receives cigarette paper from a reel **22** after it has been printed with the desired trademark or brand name by the paper printer **24**. The brand names **26**, in the cigarette machine which is symbolically illustrated in FIG. **1**, are printed in pairs, with the lettering of the names of each pair facing in opposite directions. The rod former **20** wraps the cigarette paper about the tobacco and supplies an output on conveyor **17** which is in the form of a continuous cigarette rod **28**.

The cigarette rod **28** passes a first sensing station **30** where its weight or density characteristic is monitored by a first sensing means comprising a beta gauge **32** operating in conjunction with a beta ray source **34**. The signals produced by the beta gauge **32** may be utilized for servo control of the trimmer knife **18** in a manner to be later described, and may also provide information signals indicative of more than one characteristic of the cigarette rod, such as the average density over each entire cigarette length, as well as the average density over each of a plurality of short segments within each cigarette length. In general, more than one characteristic may be monitored at a given station, and this will be discussed in greater detail hereinafter.

The cigarette rod then moves by a second sensing station **36** wherein sensing means 37, illustrated as any suitable print detector, monitors the position and imprint density of the brand names to provide an information signal indicative of these qualities. The cigarette rod **28** is then fed through a cutter **38** typically employing a knife arrangement for cutting the midpoints between printed brand names to form individual cigarettes. These are fed out of the cutter **38** with the printed ends mutually facing each other and on to a conveyor **39**. Thus, each alternate cigarette has the same orientation. The cutting blades of the cutter **38** are driven by a suitable mechanism in synchronism with a timing generator **40**, which generates timing pulses synchronized with the movements of the cigarettes on the various conveyors employed in the machine so that preferably one pulse is generated for each article interval movement, regardless of actual distances between successive cigarettes at various locations in the machine.

Each cigarette is then moved by means of the conveyor **39** past a third sensing station **44** whereat each cigarette is monitored for the presence of metal particles by sensing means **45**, which may be a conventional metal detector, for producing an information signal indicative of the presence of metal within the cigarette at the station **44**.

The cigarettes on conveyor **39** are then transferred to one of a pair of synchronized conveyors **46** and **48** by conventional material handling means so that each of the conveyors **46** and

48 carries only the cigarettes having the same printing orientation. Consequently, the movement of each pair of mutually facing cigarettes is changed from the original longitudinal orientation to a lateral movement where they are brought to a position 50 whereat suitable apparatus (not shown) may be provided for inserting a filter tip, mouthpiece, etc. on each pair of cigarettes at their mutually facing ends. Such apparatus may receive the filter tips, mouthpieces, etc. from a supply which is symbolically shown as 52 in any conventional manner.

For convenience of reference, the cigarettes having the brand name printed on the leading end as they are moved on conveyor 39 are herein designated as "A" cigarettes and follow conveyor path 46, while those cigarettes having the brand name printed on the trailing end are herein designated as "B" cigarettes and follow conveyor path 48. The pairs of cigarettes are moved by these conveyors to a fourth sensing station 54 whereat sensing means 55 performs a leak test to provide an information signal indicative of a perforation or tear in the papers of the A and B pair of cigarettes at the station. After the cigarettes leave this fourth station, a filter cutter 57 slices each filter at its midpoint so that each respective half becomes the filter for a completed A or B cigarette. Then, after the filter-cutting operation, the A cigarettes are transferred to another conveyor 56 having a speed somewhat slower than the conveyor 46 so that the cigarettes have somewhat less distances therebetween. At the same time, the B cigarettes are transferred to a conveyor 58 which may include a suitable rotating mechanism or wheel for turning the B cigarettes about to give them the same orientation as the A cigarettes, as shown. The path thus divides into two parts, and alternate A and B cigarettes are directed into the respective parts. The speed of the conveyor 58 is synchronously related to the speed of the conveyor 56 so that one B cigarette is inserted between each A cigarette at a combining location 60 whereat suitable and known material handling means are provided to perform the combining operation.

After the A and B cigarettes are recombined at the combining point 60, they pass a fifth sensing station 62 whereat a further sensing means 63 monitors each cigarette at the station for loose ends in a well known manner, and provides an information signal indicative of this characteristic. The cigarettes then pass through an operating station 64 whereat a suitable reject device 66 ejects any cigarette found to be defective as sensed by any of the various sensing means in response to a suitable signal from a programmable delay memory and control system 70, which has previously received respective input information signals from each of the sensing means. The reject device 66 may comprise a fluid amplifier for providing a controlled air blast which rapidly ejects the selected cigarette from the normal path. The fluid amplifier permits rapid switching, and the low inertia of the air medium enables the device to operate at extremely high speed with a high degree of precision.

More particularly, turning to a specific sensing means at its respective sensing station, the sensing means 32, comprising a beta gauge, provides an output signal to a gauge controller and weight classifier circuit 68. This output signal systematically corresponds to the radiation absorption characteristic of the portion of the cigarette rod which is at the sensing station 30. The weight classifier 68 averages the signal from the beta gauge over some time base and compares this average with a predetermined reference to derive an error signal indicative of deviation from a standard. This error signal is utilized as a servosystem feedback signal to the trimmer knife 18 via line 69 for automatically adjusting the position of the knife in the directions of the arrows to reduce the deviation and maintain a relatively constant preselected tobacco density or mass per unit length. Additionally, the weight classifier 68 provides an information output signal to the programmable delay memory and control system 70 via an output line 72. This signal may be proportional to the direct output from the beta gauge 32.

The programmable delay memory and control system 70 of FIG. 1 is illustrated in somewhat more detailed block form in FIG. 2 wherein the information signal on line 72 is shown as a first input to a categorizing means illustrated as comparator 100. The comparator 100 receives additional input lines 73, 74, 75 and 76 from the other respective sensing means 37, 45, 55 and 63 to provide the respective information signals to the comparator 100 corresponding to each of the respective sensed characteristics. The comparator 100 operates in conjunction with reference signals or levels supplied from standards circuit 102 for each of the information input signals to derive respective category signals on corresponding output lines 78, 79, 80, 81 and 82, which indicate whether or not the respective information signal is within given limits. The category signals thus indicate the respective category of each of the cigarettes, i.e., reject or accept, at each respective sensing station.

In order to establish the relation between the input information signals and each of the cigarettes moving through the sensing stations, the timing pulses generated by the timing generator 40 are fed to the programmable delay memory and control system 70 via a line 84, and these pulses are fed to the comparator 100 to define each article interval movement of the cigarettes. The comparator 100 may also include any desired additional timing and control means for establishing the precise instant or period of time within each article interval for interrogating the appropriate sensing means in a conventional manner and comparing the respective information signals with their respective reference standards. The respective category or accept/reject signals thus produced may be stored temporarily by any suitable two-stage storage means, such as flip-flop, for each respective category signal until the storage means are interrogated during each article interval movement by cyclic switching means, illustrated as an input data multiplexer 104, which is driven by a control pulse generator 106 in response to the timing pulses on line 84.

In the particular case of the mass characteristic information signal from the beta gauge sensing means 32 on line 72, the comparator 100, utilizing an appropriate standard from the standards circuit 102, provides a reject signal on line 78 when upon comparison of the information signal with the standard, the information signal deviates from the standard by more than a predetermined amount as determined by the desired range of acceptance or tolerance. The information signal from beta gauge 32, typically in the form of an electrometer amplifier output voltage, may be applied to an integrating circuit of conventional type employing a capacitor, and the voltage across the capacitor resulting from the accumulated charge over a cigarette interval may then be compared with a pair of reference voltage thresholds defining a band of acceptable mass per unit length values so that a reject category signal will be produced when the voltage across the capacitor at a given time is either above or below the respective upper and lower threshold voltages, indicating that the cigarette is too light or too heavy. After interrogation, or when the cigarettes have moved one article interval, the capacitor charge is dumped by an appropriate means operating in response to the timing pulses on line 84.

As previously mentioned, the information signal from the beta gauge 32 may also be utilized to derive reject signals in response to any of preselected discrete segments of a cigarette having a mass per segment which deviates from a given standard by more than a predetermined amount to assure uniformity of mass distribution in each cigarette. The same sort of capacitor-type integrating technique as discussed above may be employed, but with the means for dumping the capacitor charge being actuated after the comparison operation on the charge corresponding to each segment, and any resulting reject category signal is held for interrogation. Suitable operating signals may be readily derived by appropriately dividing the intervals between timing pulses on line 84 into a number of pulses equal to the number of segments per cigarette being sensed. Four to six segments per cigarette are typical, and the acceptance band for the segment mass characteristic is preferably set to permit a greater percentage deviation than the acceptance band for the average overall mass per cigarette.

The print detector, metal detector, leak detector and loose-end detector also provide their respective information signals to the comparator **100** where they are each compared to an appropriate reference from the standards circuit **102** to derive and hold a reject or accept category signal on a respective output line **78** to **82**.

In accordance with the present embodiment of the invention, each of the detectors is located a different predetermined number of article intervals (being particularly cigarette intervals in the present example) from a reference point which may be taken as any location along the paths to the rejection station **64**. Although the reference point may be taken at any location along the paths, in the present example, for the sake of simplicity the reference point is taken to be at the first sensing station **30**. Thus, in accordance with the previously described principles of the present invention, the first sensing station **30** is located at zero cigarette intervals from the reference point. Then, for a given or prescribed path, the second or print-sensing station **36** will be located a second predetermined number of cigarette intervals from the first sensing station **30**, the third or metal-sensing station **44** will be located a third predetermined number of cigarette intervals from the first sensing station **30**, and so on, to the fifth or loose-end sensing station **62** located downstream from the other sensing stations which is at a fifth predetermined number of cigarette intervals from the first sensing station **30**. The rejection station **64** will then be located downstream from the loose-end sensing station **62** at a sixth predetermined number of cigarette intervals from the first sensing station **30** along the prescribed paths.

It should be noted here that since the path lengths are different for the A and B cigarettes, the distance, in cigarette intervals, from the loose-end detector to the reference point at the first sensing station **30** will differ depending on whether the A cigarette path or the B cigarette path is followed. Likewise, the distances between the rejection station **64** and the references point will differ depending on whether the A cigarette or B cigarette path is followed. Thus, in the present example, any sensing or operating stations located after the cigarettes are separated into plural paths which do not have a one-to-one phase correspondence of article intervals will have associated therewith more than one distance, in article intervals, from the referen⌐ point. Since the B cigarettes are recombined alternate_ ɔetween the A cigarettes, the alternate distances of the station **62** from the reference point will differ by an even number. This will likewise be true for the alternate distances of the reject station **64** from the reference point.

Referring to FIG. 2, an N state counter **108** responds to the cigarette interval timing pulses on line **84** which are synchronized with the cutter **38** and with the movement of the cigarettes throughout the process to present one pulse for each cigarette interval movement. In response to the timing pulses on line **84**, the counter **108** counts each cigarette interval movement in a register and provides a count signal output **110** which is indicative of the number registered in the counter. An addressable N word nondestructive memory **112** having N memory cells (i.e., one bit per word) has input means shown symbolically as input line **114** through which signals may be written into the memory cells for storage, output means symbolically illustrated as output line **116** through which the stored signals may be read out, and address selection means, illustrated symbolically by line **118**, for addressing, i.e., selecting, the cells into which the signals at the input **114** are written and from which the stored signals are read at the output **116**.

A write strobe signal is fed from the multiplexer **104** to the memory **112** via line **115** to enable or gate the memory so that the signal at the input **114** will be written into the addressed cell. It is, of course, understood that, depending on the type and characteristics of the memory employed in any particular construction, the utilization of such a write strobe signal may not be necessary.

Programmed addressing means, illustrated as the address constant selection array **120**, provides a sensing station signal or constant corresponding to each respective predetermined number of cigarette intervals that each sensing station is from the reference point for a particular path. The address constant selection array also provides an operating station address signal or constant corresponding to the particular predetermined number of article intervals that the operating station is from the reference station along a prescribed path.

The respective sensing station address signals and the operating station address signal are generated from a preprogrammed diode array in response to control signals applied to the address constant selection array **120** from the control pulse generator **106**, and these signals are fed to arithmetic combining means illustrated as the address subtractor **122** which also receives the count signal from the counter **108**. During each cigarette interval movement and in response to respective control pulses, the address subtractor **122** successively subtracts each respective sensing station address constant and the operating station address constant from the registered count signal. The address subtractor provides via line **118** to the memory address selection means respective writing memory address signals corresponding to the difference between the number registered in the counter **108** and the respective predetermined numbers of cigarette intervals that the sensing stations are from the reference point, and also provides a reading memory address signal corresponding to the difference between the same number registered in the counter **108** and the number of cigarette intervals that the operating station is from the reference point.

Cyclic switching means, including the input data multiplexer **104** and the control pulse generator **106**, are responsive to the cigarette interval timing pulses on line **84** to provide, as previously indicated, a plurality of sensing control signals and a reading control signal which are applied successively in a predetermined sequence to the address constant selection array **120**, and these sensing control signals are also applied to the input data multiplexer **104** to synchronously interrogate the category signals on the multiplexer input lines **78** through **82** and apply any reject category signal which may be present to the input **114** of the memory **112** during the application of respective writing memory address signals from the address subtractor **122**. The control pulse generator **106** also supplies a read signal via a line **124** to the memory **112** during the application of the reading memory address signal to apply the respective stored signal from the memory output of line **116** to a reject mechanism controller **126**. The controller **126** operates the reject mechanism after a short delay to avoid the undesired effects of system transients by having a delayed read strobe pulse applied from the control pulse generator **106** via a line **128**.

The input data multiplexer **104** also includes means, to be described hereinafter, which are coupled to the memory **112** and are responsive to the control pulse generator **106** for clearing each respective memory cell (1) no earlier than the reading of the stored signal therefrom on line **116**, (2) no later than the writing of the next reject category signal therein, and (3) no later than during the application to the memory **112** of the respective cell's writing memory address first occurring after the reading of the stored signal on line **116**. In the illustrated example, the clearing of a memory cell is accomplished by the first control pulse of a cycle from generator **106**, which pulse is associated with the first sensing station address and the multiplexing of the category signal from the beta gauge **32** at the first sensing station **30**. A detailed discussion of this clearing operation will be presented hereinafter.

Referring now to FIG. 3 there is shown a preferred logic implementation of the system of FIG. 2. In particular, the cigarette interval timing pulses on line **84** are supplied to the control pulse generator **106**, to the N state counter **108**, and to an alternating switching circuit 130 of any suitable type. The alternating switching circuit 130 alternately pulses the A and B output terminals 132 and 134 with each successive interval timing pulse on line 84 so that the A output pulses correspond to A cigarettes and the B pulses correspond to B cigarettes. Since the interval timing pulses are synchronized with cutter 38, and all of the various conveyors, this alternate pulse relationship with the A and B cigarettes will hold true throughout the manufacturing process from the initial cigarette rod at the first sensing station 30 to the reject station 64.

The counter 108, as previously indicated, registers a count for each cigarette interval timing pulse, and thus accumulates the count of the cigarette interval movements up to its maximum state N; after which it begins again from zero.

At the control pulse generator, the interval timing pulses are fed to the set terminal of a flip-flop circuit 136 through an inverter 138. The output of the flip-flop at 140 is applied to the K terminal of a J–K flip-flop 142. A free-running oscillator 144, which may be a conventional astable multivibrator, supplies a relatively high-frequency pulse train to the T terminal of the J–K flip-flop 142 and to one input of NAND-gate 146. The other input of the NAND-gate 146 is connected to the $\bar{Q}$ output terminal of the J–K flip-flop 142. The J terminal of the flip-flop 142 is connected directly to ground. Consequently, upon the occurrence of the interval timing pulse on line 84, the NAND-gate 146 is enabled by the J–K flip-flop 142 so as to apply the pulse train from the oscillator 144 on the NAND-gate output line 148. The pulse train on line 148 is fed to a circuit 150 comprising a conventional binary counter coupled to a binary-to-decimal decoder which provides control signals in the form of sequential pulses on each of the eight output channels, O through 7. That is, in synchronism with the pulse train on lead 148, successive pulses will appear on each of the eight output channels of the counter and decoder circuit 150. Thus, at a first time in the cycle a pulse will appear on channel 0 to provide a control signal S_0 on line 152. Thereafter, at a second time in the cycle, a pulse will appear on channel 1 to provide a control signal S_1 on line 153. Thereafter, a third control signal pulse S_2 will appear on line 154, and so on, for signals S_3, S_4, S_5, and S_6, on respective lines 155 through 158. Each of these output pulses from the counter and decoder 150, as well as the output pulse from the last channel, are inverted by respective inverters serially connected in each respective line to provide the appropriate logical state for proper functioning in the system.

The last control pulse S_7 of a sequence or cycle is fed back to an input of a NAND-gate 160 which also receives at its other input delayed signals which are generated by a delay circuit 162 in response to the pulse train on lead 148. The delay circuit 162 may be a conventional monostable multivibrator. The combined signals from the delay circuit 162 and channel 7 of circuit 150 cause the output of the NAND-gate 160 to reset the flip-flop 136 and the J–K flip-flop 142, the latter of which disables the NAND-gate 146, holding the output on lead 148 at a constant level.

The control signals S_0 through S_7 are utilized to perform two functions in the system. First, these control signals are used to transfer the appropriate address constants preprogrammed in the diode array 120 to the address subtractor 122, the address constants corresponding respectively to the distance in cigarette lengths of each of the stations from the reference point. Second, the control signals S_0 through S_6 are fed to the input data multiplexer 104 to interrogate or strobe each of the category signals on respective input leads 78 through 82, and the control signal S_7 is used to actuate a strobe signal for reading out the memory to the reject device at the last station. Since the same control signals are utilized for both of these functions, they are necessarily in synchronism, and each address signal which is applied to the memory 112 will be appropriately timed to each respective category signal being interrogated.

Turning first to the control of the address constant selection array 120, this array comprises a diode matrix having a plurality of input terminal pairs 164*a* and *b*, through 167*a* and *b*, a plurality of single input terminals 168 through 170, and a plurality of output terminals 171 through 179. Respective diodes are connected between each input terminal and respective output terminals in accordance with the respective predetermined number of article intervals, or delays, between the reference point or station and each of the other stations, including both the sensing stations and the operating station, for each prescribed path between the first and last stations. Thus, upon application of a respective control signal S_0 through S_7 to a respective input terminal, the preprogrammed address constant for the respective stations will appear as a parallel 9-bit output signal on the output terminals connected through the diodes to the respective input terminal. The diodes are poled in a manner to prevent the signal on one input terminal from affecting the normal level on the others. In the present embodiment, the output signals for the respective address constants for each station equals the number (in binary form) of cigarette intervals delay between the reference point and each respective station for either the A or B cigarette paths.

More particularly, four of the inputs are paired, as indicated by the *a* and *b* designations so that the system may be utilized with four stations positioned downstream of a plural path arrangement such as is shown in FIG. 1 for the A and B cigarettes. However, in the FIG. 1 arrangement, only two stations, i.e., the loose-end station 62 and the reject station 64, would require such paired inputs to determine the proper station address. Since the system illustrated in FIGS. 3 and 4 is adapted to be used with various layouts and additional sensing stations other than depicted in FIG. 1, two additional path inputs are provided. The alternate path inputs for the control signals each comprise pairs of NAND-gates 182*a* and 182*b*, through 185*a* and 185*b*, each of which receives an input from a respective control signal, S_4 through S_7, and a second signal from either the A terminal 132 or the B terminal 134 of the alternate switching circuit 130. Consequently for each A cigarette the *a* NAND gates are enabled, and for each B cigarette, the *b* NAND gates are enabled, so as to apply the control signal to the proper input terminal of the array having the necessary preprogrammed offset or delay occasioned by the alternate path.

In practice, the diode array 120 is preferably in the form of a plug-in card having a diode connected at every matrix point. Then, for any particular sensing station and operating station layout as may be desired for any particular machine or production line, the appropriate diodes may be removed (or merely their circuit connections broken) to provide the respective station address constants at the 9-bit parallel binary output, which may be the exact number of cigarette intervals between each respective sensing station and the reference point, as previously indicated.

The address constant selection array 120 also includes an inverter, as shown, in each of the nine output terminal lines 171 through 179 to provide the appropriate logic levels for the system. These inverters may or may not be a physical part of the plug-in card itself, as desired. Each of the parallel output address constant signals is fed to a set of parallel inverters 190 which produces the one's complement of the 9-bit signal by inversion of each bit. The one's complement of each address constant is then fed to a full adder 192 which adds a 1 to the one's complement to produce the two's complement of the respective address constants. The added binary 1 is a carry-in supplied by a constant level voltage source 194. The adder 192 also receives the registered count from the N state counter 108 as a 9-bit parallel binary signal. Using two's complement binary arithmetic, and adding, the adder 192 effectively subtracts the difference between the registered count on the counter 108 and the output of the address constant selection array 120, since the sum of the two's complement of a binary number and another binary number equals the difference between the numbers, provided any carryout is ignored.

Thus, the output of the adder 192 will be the appropriate memory address for each cigarette interval movement, and will be a binary number equal to the state of the counter minus the respective cigarette interval delay. The output of the adder 192 is a 9-bit parallel binary signal (y_0 through y_8) which is fed to the corresponding terminals of the memory 112 as shown in FIG. 4.

Turning to the other function of the control signals S_0 through S_6 on leads 152 through 158, these leads are coupled, as shown in FIG. 4, to one input of respective NAND-gates 200 through 206 of the input data multiplexer 104. The category signals on input leads 78 through 82 are also applied to the input data multiplexer 104. The category signal input lead 78 is applied through an inverter 208 to one input of NAND-gate 210, the other input of which is coupled to the S_0 control signal input line 152 at the control signal input of the NAND-gate 200. The output of NAND-gate 210 is coupled to an inverter 212, through an intermediate inverter 213, and thence to the input means corresponding generally to line 114 of FIG. 2 of the memory 112. The other category signals on respective leads 79 through 82 are applied to an additional input of respective NAND-gates 201 through 204. The remaining NAND-gates 205 and 206 will not be utilized in the implementation of the specific layout illustrated in FIG. 1 since there are only five sensing stations, and thus an additional two stations could be handled by the system of FIGS. 3 and 4.

A delayed enable signal on line 215 is applied in parallel to each of the NAND-gates 200 through 206 to control the precise time for writing information into the memory 112 to assure sufficient time for address selection of the memory cell into which the information may be written by the output from the adder 192 fed to the address input 118. This also prevents errors which might be otherwise caused by system transients. The delayed enable signal is derived from the control pulse generator 106 and, particularly from the output of the delay circuit 162 (FIG. 3).

Consequently, as each respective address selection signal is applied to the memory 112 at memory address input 118, each of the category signals on lines 78 through 82 are interrogated by the successive control pulses S_0 through S_4 at times within the duration of each respective sensing address selection signal. For the information signal from the cigarette at the first sensing station 30, the cigarette weight accept/reject information is received on line 78 as a logical 1 for reject and a logical 0 for an accept. This category signal information on line 78 includes both the segment category information and the overall cigarette category information which may be merged in the comparator 100 to obtain the resulting weight classification information on line 78. Alternatively, a separate line may be brought for the segment category information from the comparator 100 to a further input of the NAND-gate 210 through a suitable inverter.

For the normal condition of this circuit, the output of the inverter 212 supplies a logical 1 or reject signal to the memory 112 which is not written into the addressed cell until a suitable write strobe signal is applied to the inverter 216. The inverter 216 applies a signal on line 115 via inverter 217. Thus, upon the occurrence of the control signal S_0 and the delayed enable which is the first control signal during a cigarette interval cycle, the output of the NAND-circuit 200 will always change its state and apply the appropriate write strobe signal to the memory 112. At the same time, the control signal S_0 is also applied to the gate 210, and if the weight classification signal on line 78 is a logical 0 or accept, the output of inverter 212 will change from its normal logical 1 to a logical 0 and an accept will be written into an addressed memory cell. This portion of the circuit performs the clear function and clears the respective memory cell regardless of the category signal on line 78, while also writing reject category signals into the respective cell if such a signal is present on line 78 during the occurrence of the control signal S_0. For example, if that particular cell had previously been in a 1 or reject state, this logical 0 signal will clear the cell by writing a 0 or accept signal therein. On the other hand, if the weight classification category signal on line 78 is a logical 1 or reject, the inverter 212 writes a 1 or reject signal into the memory with the write strobe signal on line 115. If that memory cell was previously in its 1 or reject state, it would remain in that state, but in any event would be considered cleared of previous information. This manner of clearing is advantageous in that it does not require any additional lines or sequential control pulses, but other techniques for clearing may be alternatively used so long as they clear each respective memory cell no earlier than the occurrence of the read strobe signal on line 218 and no later than the writing of the next category signal into this cell. Also, the clear must be performed no later than during the application of the respective cell's writing address signal first occurring after the previous read strobe signal.

On the occurrence of the control signal S_1 and the delayed enable signal, the output of the inverter 212 will be in its normal reject state regardless of the signal on line 78 at this time, since control signal S_0 is no longer present at the input to the gate 210. Meanwhile, if the category signal on line 79 is in its accept state, no write strobe signal will be produced from the inverter 216, and the respective memory cell remains in the state determined by the category signal previously written in. On the other hand, if the category signal on line 79 is a reject signal, a write strobe signal will be produced from the inverter 217 which will cause the normally present reject signal on line 114 to be read into this particular addressed memory cell. Likewise, a category signal on any of the other lines 80 through 82 will have no effect unless the appropriate control signal S_2 through S_4 is also applied (with the delayed enable signal), and a write strobe signal will be produced only in response to a reject category signal occurring with its respective control signal, causing the normally present reject signal on line 114 to be read into the respective cell. Since the memory 112 employs a write strobe signal on line 115 to write in reject signals on line 114, both of these lines together comprise category information input means to the memory 112.

After all of the sequential control signal pulses S_0 through S_6 have occurred during the period of a cigarette interval movement, the last or "read" control signal S_7 of the sequence, or cycle, occurs and, as shown in FIG. 3, is applied to the gate 160 which, together with the output from the delay circuit 162, causes the gate to supply a read strobe signal through the inverter 220 on lead 218 at the same time that the flip-flops 136 and 142 are reset by the output of the gate 160. The read strobe signal on line 218 is applied to the read strobe input of the memory 112 through an inverter, if required by the particular construction of the memory. Upon the application of the read strobe signal to the memory, the output of the respective cell being addressed, always corresponding to the address of the cigarette in the rejection station, will be read out at the output terminal 116. If, as will generally be the case, the addressed cell has an accept status, than a logical 0 will be read out of the cell.

On the other hand, if the cell is in its reject or logical 1 state, a 1 will be read out of the cell and the output voltage corresponding to the memory cell level will be amplified by an amplifier 222. The output from the amplifier 222 sets a memory flip-flop 224 which retains this set state until it is reset by a reset pulse on line 225 from inverter 138 (FIG. 3) in response to each new cigarette interval timing pulse occurring after a read strobe pulse.

The two outputs from the memory flip-flop 224 are fed through a reject/accept mode gating arrangement 226, which may be employed to change the normal mode of operation from ejection of only reject category cigarettes to a mode of operation wherein only accept category cigarettes are ejected by the reject mechanism 66. Normally, a logical 0 signal from an external source will be applied to the mode selection line 228 for the normal reject mode of operation. However, when a logical 1 signal is applied on the mode select line 228, the output at the pair of mode select NAND-gates 226 will cause the opposite mode of operation. This alternate mode may be used for testing, as to manually obtain a segregated sample of the cigarettes which are being classified by the system in the accept category. An inverter interconnects the NAND gate inputs not coupled to the flip-flop **224** to achieve this selectively controlled operation.

Assuming that the mode selector **226** is in its normal reject mode, a reject signal at the output **116** will cause a "reject" lamp **230** to be illuminated via an inverter **232** and a gate **234**. Also, the output from inverter **232** will be fed to one input of a NAND-gate **236**, this gate being normally enabled by the output of flip-flop **238** connected to the other input of the gate **236**. The output from the gate **236** actuates a gated pulse generator **240** which controls the duration of the reject air blast by providing an output pulse of adjustable length to a further gate **242** upon receipt of a delayed read strobe signal on line **244**. The delayed read strobe signal is generated, as shown in FIG. 3, from the output of the inverter **220** which is delayed by a delay circuit **246**. Since both the read strobe and the delayed read strobe signals are derived from the output of the inverter **220**, the delay circuit **246** will determine the precise time delay between these two signals. After the occurrence of the delayed read strobe signal, the output of the gate **242** applies an actuating signal to the valve driver of the fluid amplifier reject mechanism **66** to cause a sharp blast of air to eject the cigarette at the rejection station.

The state of the flip-flop **238** is controlled by a switch **260** which applies a ground voltage (or 0) to either the set or reset terminals of the flip-flop to maintain the reject mechanism in either the normal inspection and rejection mode of operation, or in a mode where the reject mechanism **66** does not operate, as indicated by the two positions on the switch. With the switch in the "out" position, the flip-flop **238** disables the gate **236** so that even though reject signals are read out from the memory **112** at output **116** and a delayed read strobe pulse is produced on line **244**, the reject mechanism will not operate. On the other hand, when the switch **260** is in the "in" position, the flip-flop **238** will enable the gate **236** and will also supply a signal to one input of each of the gates **262** and **264**. A second input is supplied to each of these gates from an inverter **268** which, in normal operation, causes lamp **270** to be illuminated indicating that the system is in the normal inspection-rejection mode. Similarly, the gate **262** through an inverter **272** energizes a driver circuit **274** which may be employed to energize a suitable annunciator displayed on a control panel or elsewhere.

The inverter **268** receives an input signal from NAND-gate **280** which is utilized in conjunction with certain test and diagnostic signals which are employed to operate the system in various test and diagnostic modes. For example, appropriate input signals may be applied at the input terminals **282** and **284** to the gate **280** which result in the disablement of the lamp and annunciator controlled by gates **264** and **262** to indicate that the system is not in the normal inspection and rejection mode. The signal which may be applied on terminal **284** disables gate **242** and the reject mechanism for manual, rather than automatic, operation of the cigarette machine when the servo control systems are not in operation. An additional flip-flop circuit **286** having set and reset inputs **288** and **290** may be utilized for selectively supplying a suitable signal to an additional input **292** of the delay circuit **240**, so that the reject mechanism **66** may be operated in some predetermined test modes, such as for rejecting every other cigarette, etc., by applying appropriate signals to the terminals **288** and **290**.

Thus, a classifier system has been described employing a read/write memory which has a number of memory cells at least equal to the number of cigarettes in the delay path between the first sensing station and the ultimate rejection station. The input and output controls of the memory are achieved by the use of a cyclic switching means which operates a memory address control and an input data multiplexer which is thus maintained in synchronism with the memory address control. The memory address control includes preprogrammed station address constants, a counter and a subtractor, and the counter preferably has as many states as cells in the memory so that if there are N memory cells the counter registers N states before it recycles. With the binary circuitry employed in he illustrated embodiment, the subtractor advantageously performs subtraction of the constants from the count on the counter register by using two's complement binary arithmetic. That is, inverting the binary constants to obtain the one's complement, adding one to obtain the two's complement, and adding this sum to the registered count.

Each time a cigarette moves through one cigarette interval, the counter is incremented by one state. Then within the time period of this cigarette interval the weight accept/reject information is stored in the memory at the cell address corresponding to the state of the counter (assuming that this station is taken as the reference point for the system). The category signals for the other sensing stations are then sequentially interrogated, and a reject category signal is written in the memory cell corresponding to the present counter state minus the number of cigarettes delay existing between the reference point and each of the respective stations in sequence. Thus, this operation logically "OR's" all classification information for a given cigarette from all sensors into one memory cell as the cigarette reaches each respective station in turn. Then, the accept/reject information is read from the memory cell corresponding to the present counter state minus the number of cigarettes delay between the reference point and the operating station, and if there are two different delays, such as for successive A and B of a pair, a suitable alternate delay or offset is subtracted, depending on whether the cigarette in the operating station is an A or B cigarette.

In a particular construction of an apparatus embodying the principles of the present invention, a 512-bit memory was employed to accommodate a weight classification sensor and six optional additional sensors located any place on the line before the reject mechanism. The memory address signal or 9-bit word is obtained, in the manner previously described, by adding 9 bits from the counter to 9 bits from the diode array and a carry-in. The counter can be in any binary state 0 through 511, and the diode array output can also vary between 0 and 511. As a specific example of an application of such apparatus, assume that the reference point is at the first sensing station, which may be taken as the weight classification station, and that for A cigarettes the rejection station is located 437 cigarette intervals downstream from the weight classification station. Referring to the address constant selection diode array **120** in FIG. 3, no diodes would be connected for the weight classification station address constant (since it is zero predetermined intervals from the reference), and this is equivalent to having all logical 0's on the output lines **171** through **179** from the diode array. Therefore, there are all logical 1's on the respective output lines from the set of inverters **190**. When the 1 carry-in is added to the least significant bit of the inverted output, the sum is zero since the carryout 1 bit is ignored in reading out only 9 bits. Thus, the first memory address from the adder **192** is simply the contents of the counter **108**.

The memory address is modified for each of the other stations by arranging the diode array **120** so that the number to be subtracted from the counter contents is the binary representation of the number of cigarette intervals from the reference point to the station. This is accomplished by providing a diode wherever there is a 1-bit in the binary representation of the address constant. Thus, if we consider the reject mechanism, at **437** cigarette intervals away from the weight classification in our example, then in the state of the system corresponding to the occurrence of the control signal S_7, the number **437** should be subtracted from the counter state to obtain the memory address. To do this, the binary equivalent of **437** is obtained. This number to the base 2 is 110110101. Then, as shown in FIG. 3, diodes are placed in the **1**, **4**, **16**, **32**, **128**, and **256** places of the diode array **120** from input terminal **164***a* to each respective output terminal, the output terminals going from the least to the most significant bit from the bottom to top as illustrated.

Also shown, are the diode connections for the alternate path for B cigarettes, the diodes being connected from input terminal **164*b*** to the respective output terminals. In this example, it is assumed that there is a 10-cigarette interval difference between the B and A cigarette paths with the B path 10 intervals longer. Thus, with respect to B cigarettes, the rejection station is 447-cigarette intervals from the weight classification station. The number 447 to the base 2 is 110111111. Referring to the input terminal **164*b***, it can be seen that a diode is present for each of the places except for the **64** place, which is zero, and no diode is there employed.

Any other delay can be programmed in the same manner, and it is necessary only to know in which state of the cyclic switching means it is desired to have the memory modified, and the distance from the respective station to the reference point.

Although in the present embodiment the control signals from the cyclic switching means followed a predetermined sequence corresponding to the order of the stations along the production line, this does not necessarily have to be the case, and these control signals may bear a "scrambled" relation to the actual order of the sensing stations. Likewise, although the last of such sequence control signals provided the read strobe signal, other alternative timing arrangements may be employed. Furthermore, although a particular type of nondestructive type of memory has been disclosed, other types of memory may alternatively be employed. However, the memory of the illustrated embodiment may conveniently be constructed by employing commercially available 64-bit static random access memory circuits in the form of MOS integrated circuits, such as the Fairchild number 3530, to form a multichip memory in a well known manner. Additionally a suitable counter may be coupled to the output of the memory to provide an indication of the total number of rejects regardless of the operating state of the reject mechanism. The delay circuits in the illustrated embodiment may conveniently comprise retriggerable monostable multivibrators, such as the Fairchild TTμL9601.

Although particular logic circuits principally utilizing NAND gates have been herein illustrated and described for implementation of the present embodiment of the invention, it is of course understood that many other equivalent logic configurations, utilizing other types of logic gates as well as NAND gates, may be alternatively employed. These and other modifications of the various aspects of the present invention will be apparent to those skilled in the art; and thus, the scope of the invention should be defined only by the appended claims, and equivalents thereof.

Various features of the invention are set forth in the following claims.

What is claimed is:

1. A system for classifying a plurality of articles into either of first and second categories according to a sensed characteristic of each article, which articles are moved successively along at least one prescribed path past a reference point, a plurality of sensing stations, and an operating station, each of said sensing stations being located at a respective predetermined number of article intervals from said reference point, said operating station being located a further predetermined number of article intervals from said reference point and at a position following the last of said sensing stations along said path, said system comprising:

timing means synchronized with the movement of the articles along said path for providing timing pulses indicative of each article interval movement along said path,

sensing means responsive to a respective given characteristic of the article at each respective sensing station by providing a respective information signal indicative of said respective given characteristic,

categorizing means responsive to each of said information signals for providing a first category signal whenever the article at a respective sensing station is in said first category,

operating means for acting on an article at said operating station according to the category of the respective article,

a counter responsive to said timing pulses for counting each article interval movement and providing a count signal indicative of the number registered in the counter,

memory means having a plurality of memory cells, input means through which signals may be written into said memory cells for storage, output means through which the stored signals may be read out, and address selection means for selecting the cells into which the signals at said input means are written and from which the stored signals are read at said output means,

programmed addressing means for providing a sensing station address signal corresponding to each respective predetermined number of article intervals and an operating station address signal corresponding to said further predetermined number of article intervals,

combining means responsive to sensing control signals for combining said count signal and respective sensing station address signals to produce respective writing memory address signals corresponding to the difference between the number registered in the counter and the respective predetermined numbers of article intervals and applying said respective writing memory address signal to said address selection means, and responsive to an operating control signal for combining said count signal and said operating station address signal to produce a reading memory address signal corresponding to the difference between the number registered in the counter and the further predetermined number of article intervals and applying said reading memory address signal to said address selection means,

cyclic switching means responsive to a timing pulse to provide a plurality of sensing control signals and an operating control signal successively in a predetermined sequence to said combining means, and in synchronism with said control signals applying respective first category signals to said input means during the application of respective writing memory address signals to said address selection means and applying a respective stored signal to said operating means during the application of said reading memory address signal to said address selection means, and

means coupled to said memory and responsive to said cyclic switching means for clearing each respective memory cell no earlier than the reading of the stored signal therefrom, no later than the writing of the next category signal therein, and no later than during the application to said address selection means of the respective cell's writing memory address signal first occurring after said reading,

whereby information associated with the article at the respective sensing station is written into the memory when the article is at the respective sensing stations and the stored category information associated with the article at the operating station is read from the memory and utilized to actuate said operating means when the respective article is at the operating station.

2. A system for classifying a plurality of articles into either of reject and accept categories according to a sensed characteristic of each article, which articles are moved successively along at least one prescribed path past a reference point, a plurality of sensing stations, and an operating station, each of said sensing stations being located at a respective predetermined number of article intervals from said reference point, said operating station being located a further predetermined number of article intervals from said reference point and at a position following the last of said sensing stations along said path, said system comprising:

timing means synchronized with the movement of the articles along said path for providing timing pulses indicative of each article interval movement along said path,

sensing means responsive to a respective given characteristic of the article at each respective sensing station by providing a respective information signal indicative of said respective given characteristic, categorizing means responsive to each of said information signals for providing a reject signal whenever the article at a respective sensing station is in said reject category,

operating means for acting on an article at said operating station according to the category of the respective article to reject the respective article,

a counter responsive to said timing pulses for counting each article interval movement and providing a count signal indicative of the number registered in the counter,

memory means having a plurality of memory cells, input means through which signals may be written into said memory cells for storage, output means through which the stored signals may be read out, and address selection means for selecting the cells into which the signals at said input means are written and from which the stored signals are read at said output means,

programmed addressing means for providing a sensing station address signal corresponding to each respective predetermined number of articles intervals and an operating station address signal corresponding to said further predetermined number of article intervals,

combining means responsive to sensing control signals for combining said count signal and respective sensing station address signals to produce respective writing memory address signals corresponding to the difference between the number registered in the counter and the respective predetermined numbers of article intervals and applying said respective writing memory address signal to said address selection means, and responsive to an operating control signal for combining said count signal and said operating station address signal to produce a reading memory address signal corresponding to the difference between the number registered in the counter and the further predetermined number of article intervals and applying said reading memory address signal to said address selections means,

cyclic switching means responsive to a timing pulse to provide a plurality of sensing control signals and an operating control signal successively in a predetermined sequence to said combining means, and in synchronism with said control signals applying respective reject signals to said input means during the application of respective writing memory address signals to said address selection means and applying a respective stored signal to said operating means during the application of said reading memory address signal to said address selection means, and

means coupled to said memory and responsive to said cyclic switching means for clearing each respective memory cell of any reject signal nor earlier than the reading of the stored signal therefrom, no later than the writing of the next reject signal therein, and no later than during the application to said address selection means of the respective cell's writing memory address signal first occurring after said reading,

whereby reject information associated with the article at the respective sensing stations is written cumulatively into the memory when the article is at the respective sensing stations and any stored reject information associated with the article at the operating station is read from the memory and utilized to actuate said operating means to reject the respective article when it is at the operating station.

3. A system according to claim 2 wherein said means for clearing is responsive to the sensing control signal from said cyclic switching means first occuring when the respective cell is addressed following said reading, whereby the respective memory cell stores the category information derived from the information signal from the sensing means at the sensing station furthest upstream and thereafter receives signals for storage only when reject signals are derived from the information signals at respective downstream stations.

4. A system according to claim 2 wherein one of said sensing means is a radiation gauge responsive to mass per unit length of respective articles by providing an information signal indicative thereof, and wherein said categorizing means comprises a standard and a comparator for providing a reject signal when said information signal deviates from said standard by more than a predetermined amount.

5. A system for classifying a plurality of articles into either of two categories according to a sensed characteristic of each article, which articles are moved successively along at least one prescribed path past a reference point, a sensing station, and an operating station, said sensing station being located a first predetermined number of article intervals from said reference point, and said operating station being located a second predetermined number of article intervals from said reference point, said system comprising:

timing means synchronized with said movement for providing timing pulses indicative of each article interval movement along said path,

sensing means responsive to a given characteristic of each article at said sensing station by providing an information signal indicative of said given characteristic,

categorizing means responsive to said information signal for providing a category signal indicative of the category of the respective article,

operating means for acting on an article at said operating station according to the category of the respective article,

a counter responsive to said timing pulses for counting each article interval movement and providing a count signal indicative of the number registered in the counter,

memory means having a plurality of memory cells, input means through which signals may be written into the memory cells for storage, output means through which the stored signals may be read out, and address selection means for selecting the cells into which the signals at said input means are written and from which the stored signals are read at said output means,

programmed addressing means for providing a sensing station address signal corresponding to said first predetermined number of article intervals and an operating station address signal corresponding to said second predetermined number of article intervals,

combining means responsive to a sensing control signal for combining said count signal and said sensing station address signal to produce a first memory address signal corresponding to the difference between the number registered in the counter and the first predetermined number of article intervals and applying said first memory address signal to said address selection means, and responsive to an operating control signal for combining said count signal and said operating station address signal to produce a second memory address signal corresponding to the difference between the number registered in the counter and the second predetermined number of article intervals and applying said second memory address signal to said address selection means, and

cyclic switching means responsive to a timing pulse to provide successive sensing and operating control signals in a predetermined sequence to said combining means, and in synchronism with said control signals applying the category signal to said input means during the application of said first memory address signal to said address selection means and applying a respective stored signal to said operating means during the application of said second memory address signal to said address selection means,

whereby the category information associated with the article at the sensing station is written into the memory when the article is at the sensing station and the stored category information associated with the article at the operating station is read from the memory and utilized to actuate said operating means when the respective article is at the operating station.

6. The system of claim 5 wherein the number of memory cells in said memory means is no less than the difference between said first and second predetermined number of article intervals.

7. The system of claim 5 wherein the number of states in the register of said counter equals the number of memory cells in said memory means.

8. A system according to claim 5 when following said sensing station the path divides into alternate parts over one of which said operating station is a third predetermined number of article intervals from said reference point, said third predetermined number of article intervals differing from said second predetermined number by an even number, and alternate articles follow alternate respective parts of said path, in which system:

said programmed addressing means provides an alternate operating station address signal corresponding to said third predetermined number of article intervals,

said combining means is responsive to an alternate operating control signal for combining said count signal and said alternate operating station address signal to produce a third memory address signal corresponding to the difference between the number registered in the counter and the third predetermined number of article intervals and applying said third memory address signal to said address selection means, and

said cyclic switching means is responsive to alternate timing pulses to provide successive sensing and alternate operating control signals in a predetermined sequence to said combining means, and in synchronism with said sensing and alternate operating control signals applying the category signal to said input means during the application of said first memory address signal to said address selection means and applying a respective stored signal to said operating means during the application of said third memory address signal to said address selection means.

9. A system according to claim 5 wherein said programmed addressing means comprises a diode array having a plurality of input terminals and a plurality of output terminals, and a respective diode connected between each input terminal and each of respective output terminals in accordance with the respective predetermined number of article intervals, whereby upon application of a respective control signal to a respective input terminal, parallel address output signals appear upon the respective output terminals connected through said diodes to said respective input terminal, said parallel output signals forming a respective station address signal.

10. A system according to claim 9 wherein said parallel address output signals are in binary code and said combining mans includes inverter means associated with said output terminals for converting said address output signals to their one's complements, and means for adding one as a carry-in signal to the sum of respective one's complements and the count in the register of said counter.

11. A system for classifying cigarettes into either of reject and accept categories according to the mass per unit length of each cigarette, which cigarettes are moved successively along at least one prescribed path past a reference point, a sensing station, and an operating station, said sensing station being located a first predetermined number of cigarette intervals from said reference point, and said operating station being located a second predetermined number of cigarette intervals from said reference point, said system comprising:

timing means synchronized with said movement for providing timing pulses indicative of each cigarette interval movement along said path,

a radiation gauge responsive to the mass per unit length of each cigarette at said sensing station by providing an information signal indicative of said mass per unit length,

categorizing means responsive to said information signal comprising a standard and a comparator for providing a reject signal when said information signal deviates from said standard by more than a predetermined amount,

operating means for acting on a cigarette at said operating station according to the category of the respective article to reject each cigarette in the reject category,

a counter responsive to said timing pulses for counting each cigarette interval movement and providing a count signal indicative of the number registered in the counter,

memory means having a plurality of memory cells, input means through which signals may be written into the memory cells for storage, output means through which the stored signals may be read out, and address selection means for selecting the cells into which the signals at said input means are written and from which the stored signals are read at said output means,

programmed addressing means for providing a sensing station address signal corresponding to said first predetermined number of cigarette intervals and an operating station address signal corresponding to said second predetermined number of cigarette intervals,

combining means responsive to a sensing control signal for combining said count signal and said sensing station address signal to produce a first memory address signal corresponding to the difference between the number registered in the counter and the first predetermined number of cigarette intervals and applying said first memory address signal to said address selection means, and responsive to an operating control signal for combining said count signal and said operating station address signal to produce a second memory address signal corresponding to the difference between the number registered in the counter and the second predetermined number of cigarette intervals and applying said second memory address signal to said address selection means,

cyclic switching means responsive to a timing pulse to provide successive sensing and operating control signals in a predetermined sequence to said combining means, and in synchronism with said control signals applying any respective reject signal to said input means during the application of said first memory address signal to said address selection means and applying a respective stored signal to said operating means during the application of said second memory address signal to said address selection means,

whereby the reject information associated with the cigarette at the sensing station is written into the memory when the cigarette is at the sensing station and any stored reject information associated with the cigarette at the operating station is read from the memory and utilized to actuate said operating means to reject the respective cigarette when it is at the operating station.

12. A system according to claim 11 including means responsive to signals from said radiation gauge for providing a signal to control the amount of tobacco in the cigarettes as they are made.

13. For use in a system for classifying a plurality of articles into either of two categories according to a sensed characteristic of each article, said system having conveying means for moving successive articles along at least one prescribed path past a reference point, a sensing station, and an operating station, said sensing station being located a first predetermined number of article intervals from said reference point, and said operating station being located a second predetermined number of article intervals from said reference point, sensing means responsive to a given characteristic of each article at said sensing station by providing an information signal indicative of said given characteristic, categorizing means responsive to said information signal for providing a category signal indicative of the category of the respective article, and operating means for acting on an article at said operating station according to the category of the respective article, apparatus comprising:

timing means for providing timing pulses synchronized with said movement and indicative of each article interval movement along said path,

a counter responsive to said timing pulses for counting each article interval movement and providing a count signal indicative of the number registered in the counter,

memory means having a plurality of memory cells, input means through which signals may be written into the memory cells for storage, output means through which the stored signals may be read out, and address selection means for selecting the cells into which the signals at said input means are written and from which the stored signals are read at said output means,

programmed addressing means for providing a sensing station address signal corresponding to said first predetermined number of article intervals, and an operating station address signal corresponding to said second predetermined number of article intervals,

combining means responsive to a first control signal for combining said count signal and said sensing station address signal to produce a first memory address signal corresponding to the difference between the number registered in the counter and the first predetermined number of article intervals and applying said first memory address signal to said address selection means, and responsive to a second control signal for combining said count signal and said operating station address signal to produce a second memory address signal corresponding to the difference between the number registered in the counter and the second predetermined number of articles intervals and applying said second memory address signal to said address selection means, and

cyclic switching means responsive to a timing pulse for providing first and second successive control signals in a predetermined sequence to said combining means, and in synchronism with said control signals applying the category signal to said input means during the application of said first memory address signal to said address selection means and applying a respective stored signal to said operating means during the application of said second memory address signal to said address selection means

whereby the category information associated with the article at the sensing station is written into the memory when the article is at the sensing station and the stored category information associated with the article at the operating station is read from the memory and utilized to actuate said operating means when the respective article is at the operating station.

14. Apparatus according to claim 13 wherein said programmed addressing means comprises a diode array having a plurality of input terminals and a plurality of output terminals, and a respective diode connected between each input terminal and each of respective output terminals in accordance with the respective predetermined number of article intervals, whereby upon application of a respective control signal to a respective input terminal, parallel address output signals appear upon the respective output terminals connected through said diodes to said respective input terminal, said parallel output signals forming a respective station address signal.

15. A system according to claim 14 wherein said parallel address output signals are in binary code and said combining means includes inverter means associated with said output terminals for converting said address signals to their one's complements, and means for adding one as a carry-in signal to the sum of respective one's complements and the count in the register of said counter.

16 A method of classifying a plurality of articles into either of first and second categories according to a sensed characteristic of each article, said method comprising:

moving the articles successively along at least one prescribed path past a reference point, a plurality of sensing stations, and an operating station, each of said sensing stations being located at a respective predetermined number of article intervals from said reference point, said operating station being located a further predetermined number of article intervals from said reference point and at a position following the last of said sensing stations along said path,

counting each article movement and keeping a total count,

sensing a respective given characteristic of the article at each respective sensing station,

categorizing each article as in one of said first and second categories at each respective sensing station according to the sensed characteristic,

writing each indication that an article is in said first category into a respective memory cell of a memory having an address corresponding to the difference between said total count and the respective predetermined number of article intervals corresponding to the respective sensing stations,

reading the indication of category contained in the memory cell having an address corresponding to the difference between said total count and said further predetermined number of article intervals,

operating upon the respective article at said operating station in accordance with the category information read out, and

clearing each respective memory cell no earlier than the reading of the stored signal therein, no later than while the respective memory cell is next addressed for writing information therein, and no later than when information is next written therein.

17. A method of classifying a plurality of articles into either of first and second categories according to a sensed characteristic of each article, said method comprising:

moving the articles successively along at least one prescribed path past a reference point, a plurality of sensing stations, and an operating station, each of said sensing stations, being located at a respective predetermined number of article intervals from said reference point, said operating station being located a further predetermined number of article intervals from said reference point and at a position following the last of said sensing stations along said path,

providing timing pulses indicative of each article interval movement along said path and utilizing the timing pulses to provide a plurality of sensing control signals and an operating control signal successively in a predetermined sequence,

sensing a respective given characteristic of the article at each respective sensing station by providing a respective information signal indicative of said respective given characteristic,

categorizing each article as in one of said first and second categories at each respective sensing station according to each of of said information signals by providing a first category signal whenever the article at a respective sensing station is in said first category,

counting each article interval movement and providing a count signal indicative of the number registered in a counter,

providing a sensing station address signal corresponding to each respective predetermined number of article intervals and an operating station address signal corresponding to said further predetermined number of article intervals,

upon occurrence of sensing control signals, combining said count signal and respective sensing station address signals to produce respective writing memory address signals corresponding to the difference between the number registered in the counter and the respective predetermined numbers of article intervals, utilizing each of the respective writing memory address signals to address a respective memory cell in a memory, and writing a respective first category signal into the address memory cell,

upon occurrence of an operating control signal, combining said count signal and said operating station address signal to produce a reading memory address signal corresponding to the difference between the number registered in the counter and the further predetermined number of article intervals, utilizing the reading memory address signal to address a respective memory cell in the memory, and reading a respective stored signal from the addressed memory cell,

acting on the article at said operating station according to the respective stored signal read out,

clearing such respective memory cell no earlier than the reading of the stored signal therein and no later than while the respective memory cell is next addressed for writing information therein and no later than when information is next written therein,

whereby the category information associated with the article at the respective sensing stations is written into the memory when the article is at the sensing stations and the stored category information associated with the article at the operating station is read from the memory and utilized to act on the respective article when it is at the operating station.

18. A method of classifying a plurality of articles into either of two categories according to a sensed characteristic of each article, said method comprising;

moving successive articles along at leas one prescribed path past a reference point, a sensing station, and an operating station, said sensing station being located a first predetermined number of article intervals from said reference point, and said operating station being located a second predetermined number of article intervals from said reference point,

providing timing pulses indicative of each article interval movement along said path, and utilizing the timing pulses to provide a sensing control signal and an operating control signal successively in a predetermined sequence,

sensing a given characteristic of each article at said sensing station by providing an information signal indicative of said given characteristic,

categorizing each article in response to said information signal by providing a category signal indicative of the category of the respective article,

counting each of article interval movement and providing a count signal indicative of the number registered in a counter,

providing a sensing station address signal corresponding to said first predetermined number of article intervals and an operating station address signal corresponding to said second predetermined number of article intervals,

upon occurrence of a sensing control signal combining said count signal and said sensing station address signal to produce a first memory address signal corresponding to the difference between the number registered in the counter and the first predetermined number of article intervals, and utilizing the first memory address signal to address a respective memory cell in a memory, and writing a respective category signal into the addressed memory cell,

upon occurrence of an operating control signal, combining said count signal and said operating station address signal to produce a second memory address signal corresponding to the difference between the number registered in the counter and the second predetermined number of article intervals, utilizing the second memory address signal to address a respective memory cell in the memory, and reading a respective stored signal from the addressed memory cell, and

acting on the article at said operating station according to the respective stored signal read out,

whereby the category information associated with the article at the sensing station is written into the memory when the article is at the sensing station and the stored category information associated with the article at the operating station is read from the memory and utilized to act on the respective article when it is is at the operating station.

19. A method according to claim 18 wherein following said sensing station the path is divided into alternate parts over one of which said operating station is a third predetermined number of article intervals from said reference point, said third predetermined number of article intervals differing from said second predetermined number by an even number, said method further comprising:

moving alternate articles over alternate respective parts of the path,

providing an alternate operating station address signal corresponding to said third predetermined number of article intervals, and

upon occurrence of an alternate operating control signal, combining said count signal and said alternate operating station address signal to produce a third memory address signal corresponding to the difference between the number registered in the counter and the third predetermined number of article intervals, utilizing the third memory address signal to address a respective memory cell in the memory, and reading a respect stored signal from the addressed memory cell.

20. A method of classifying a plurality of articles into either of reject or accept categories according to a sensed characteristic of each article, said method comprising:

moving the articles successively along at least one prescribed path past a reference point, a plurality of sensing stations, and an operating station, each of said sensing stations being located at a respective predetermined number of article intervals from said reference point, said operating station being located a further predetermined number of article intervals from said reference point and at a position following the last of said sensing stations along said path,

providing timing pulses indicative of each article interval movement along said path and utilizing the timing pulses to provide a plurality of sensing control signals and an operating control signal successively in a predetermined sequence,

sensing a respective given characteristic of the article at each respective sensing station by providing a respective information signal indicative of said respective given characteristic,

categorizing each article as in one of said reject and accept categories at each respective sensing station according to each of said information signals by providing a reject signal whenever the article at a respective sensing station is in said reject category,

counting each article interval movement and providing a count signal indicative of the number registered in a counter,

providing a sensing station address signal corresponding to each respective predetermined number of article intervals and an operating station address signal corresponding to said further predetermined number of article intervals,

upon occurrence of sensing control signals, combining said count signal and respective sensing station address signals to produce respective writing memory address signals corresponding to the difference between the number registered in the counter and the respective predetermined numbers of article intervals, utilizing each of the respective writing memory address signals to address a respective memory cell in a memory, and writing a respective reject signal into the addressed memory cell,

upon occurrence of an operating control signal, combining said count signal and said operating station address signal to produce a reading memory address signal corresponding to the difference between the number registered in the counter and the respective predetermined number of article intervals, utilizing the reading memory address signal to address a respective memory cell in the memory, and reading any respective stored signal from the addressed memory cell,

rejecting the article at said operating station upon reading out a respective stored reject signal,

clearing each respective memory cell no earlier than the reading of the stored signal therein, no later than while the respective memory cell is next addressed for writing information therein and no later than when information is next written therein,

whereby reject information associated with the article at the respective sensing stations is written cumulatively into the memory when the article is at the respective sensing stations and any stored reject information associated with the article at the operating station is read from the memory and utilized to reject the respective article when it is at the operating station.

21 A method of classifying cigarettes into either of reject and accept categories according to the mass per unit length of each cigarette, said method comprising:

moving successive cigarettes along at least one prescribed path past a reference point, a sensing station, and an operating station, said sensing station being located a first predetermined number of cigarette intervals from said reference point, and said operating station being located a second predetermined number of cigarette intervals from said reference point,

providing timing pulses indicative of each cigarette interval movement along said path, and utilizing the timing pulses to provide a sensing control signal and an operating control signal successively in a predetermined sequence,

with a radiation gauge sensing the mass per unit length of each cigarette at said sensing station by providing an information signal indicative of said mass per unit length,

comparing the information signal against a standard and providing a reject signal when the information signal deviates from the standard by more than a predetermined amount,

counting each cigarette interval movement and providing a count signal indicative of the number registered in a counter,

providing a sensing station address signal corresponding to said first predetermined number of cigarette intervals and an operating station address signal corresponding to said second predetermined number of cigarette intervals,

upon occurrence of a sensing control signal combining said count signal and said sensing station address signal to produce a first memory address signal corresponding to the difference between the number registered in the counter and the first predetermined number of article intervals, and utilizing the first memory address signal to address a respective memory cell in a memory, and writing any respective reject signal into the addressed memory cell,

upon occurrence of an operating control signal, combining said count signal and said operating station address signal to produce a second memory address signal corresponding to the difference between the number registered in the counter and the second predetermined number of article intervals, utilizing the second memory address signal to address a respective memory cell in the memory, and reading any respective stored signal from the addressed memory cell, and

rejecting the cigarette at said operating station upon reading out a respective reject signal,

whereby the reject information associated with the cigarette at the sensing station is written into the memory when the cigarette is at the sensing station and any stored reject information associated with the cigarette at the operating station is read from the memory and utilized to reject the respective cigarette when it is at the operating station.